US007426081B2

(12) **United States Patent**
Paik et al.

(10) **Patent No.: US 7,426,081 B2**
(45) **Date of Patent: Sep. 16, 2008**

(54) **LENS TRANSFER DEVICE**

(75) Inventors: **Ki Mun Paik**, Kyungki-do (KR); **Youn Kyun Bin**, Kyungki-do (KR); **Jung Seok Lee**, Kyungki-do (KR); **Dong Kyun Lee**, Seoul (KR); **Byung Woo Kang**, Seoul (KR); **Jung Ho Ryu**, Kyungki-do (KR); **Sung Deuk Kim**, Seoul (KR); **Burhanettin Koc**, Kyungki-do (KR)

(73) Assignee: **Samsung Electro-Mechanics Co., Ltd.**, Suwon (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **11/585,283**

(22) Filed: **Oct. 24, 2006**

(65) **Prior Publication Data**

US 2007/0091463 A1 Apr. 26, 2007

(30) **Foreign Application Priority Data**

Oct. 24, 2005 (KR) 10-2005-0100199

(51) **Int. Cl.**
G02B 15/14 (2006.01)
G02B 27/00 (2006.01)

(52) **U.S. Cl.** **359/694**; 359/822

(58) **Field of Classification Search** 359/694, 359/696–698, 703–704, 813–814, 822–826
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,490,015 A * 2/1996 Umeyama et al. 359/824
5,768,038 A 6/1998 Emura 359/824
5,812,330 A * 9/1998 Akada 359/823
6,215,605 B1 4/2001 Kuwana et al.
6,268,970 B1 7/2001 Ito et al.
2005/0067922 A1 3/2005 Sasaki et al. 310/323.09

FOREIGN PATENT DOCUMENTS

EP 1 753 040 2/2007
EP 1 753 041 2/2007
EP 1 753 044 2/2007

(Continued)

OTHER PUBLICATIONS

British Office Action issued Feb. 14, 2007 in corresponding British Patent Application No. GB0621121.3.

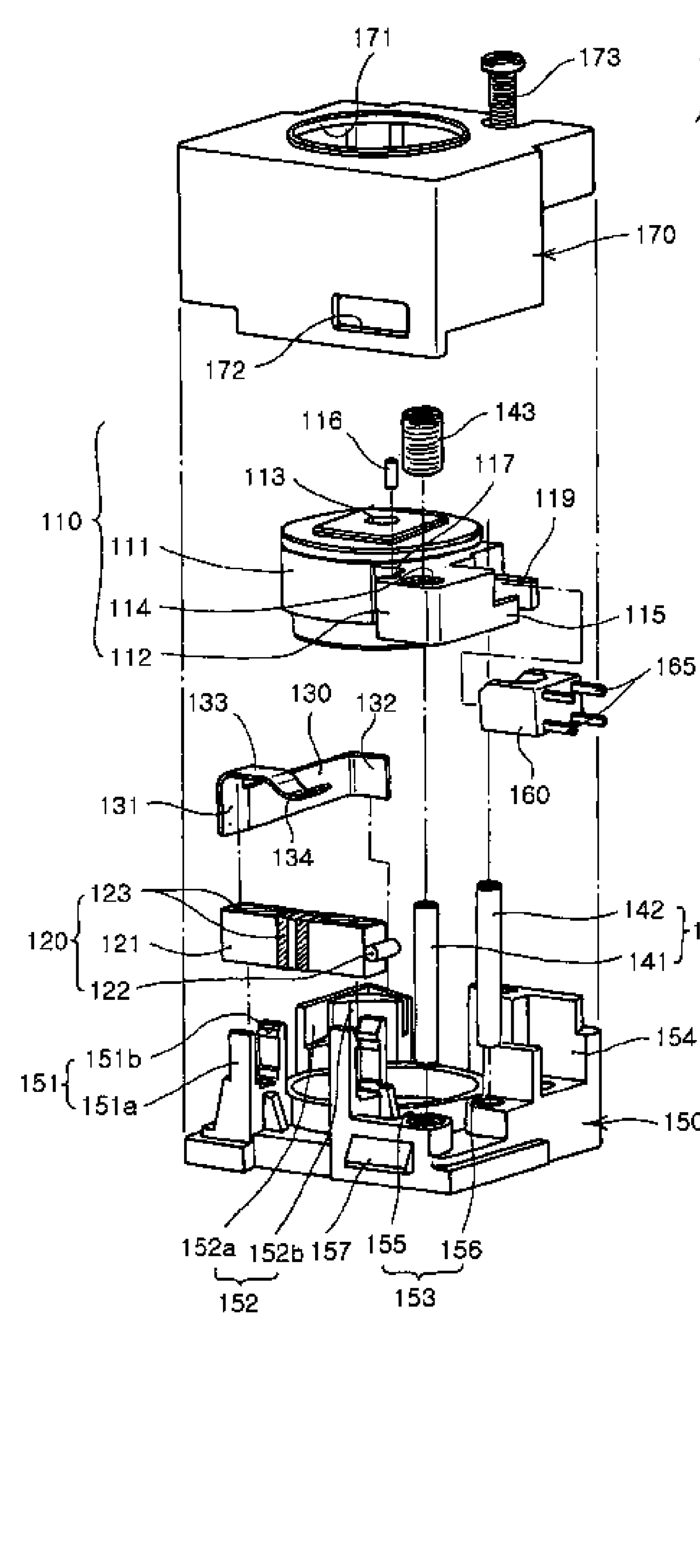
(Continued)

Primary Examiner—Scott J. Sugarman
Assistant Examiner—Dawayne A Pinkney

(57) **ABSTRACT**

The invention provides a lens transfer device including at least one lens and a lens barrel. The lens barrel has a lens receiving part with the lens arranged in an inner space thereof and an extension extending radially from an outer surface of the lens receiving part. An actuator has a body and an output member at a leading end of the actuator to contact the extension, and is adapted to expand/contract and bend in response to an external supply voltage to provide a driving force necessary for transfer of the lens barrel through the output member. A pressing member has a free end contacting a rear end of the actuator to force the actuator against the extension, and a guide guides the transfer of the lens barrel along an optical axis.

18 Claims, 9 Drawing Sheets



FOREIGN PATENT DOCUMENTS

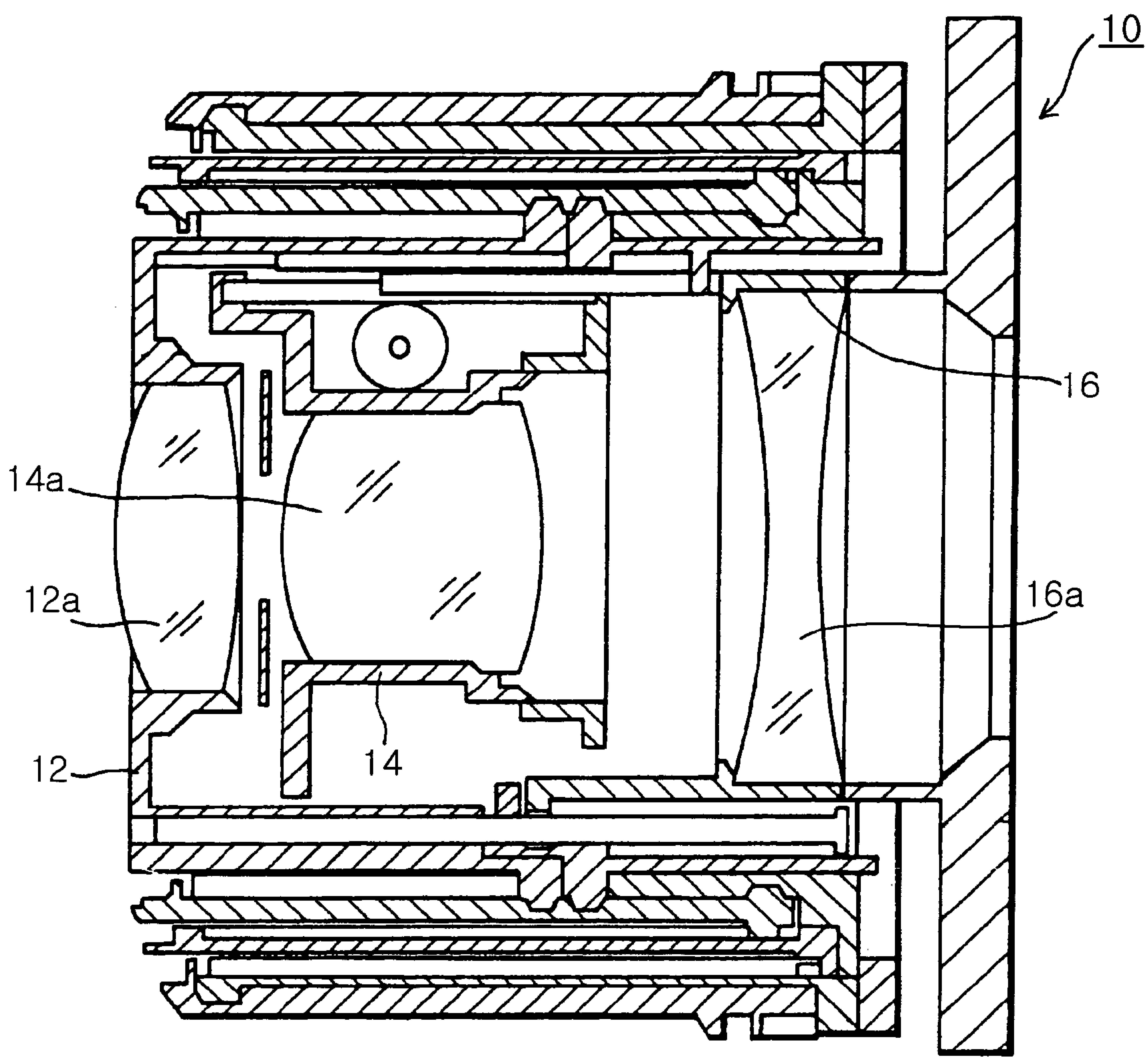
JP	5-88066	4/1993
JP	6-94964	4/1994
JP	7-104166	4/1995
JP	10-90584	4/1998
JP	11-346486	12/1999
JP	2001-45777	2/2001
JP	2005-354832	12/2005
JP	2006-101611	4/2006
JP	2006098577	4/2006

OTHER PUBLICATIONS

UK Intellectual Property Office Examination Report, mailed Jul. 1, 2008 and issued in corresponding UK Patent Application No. GB0621121.3.

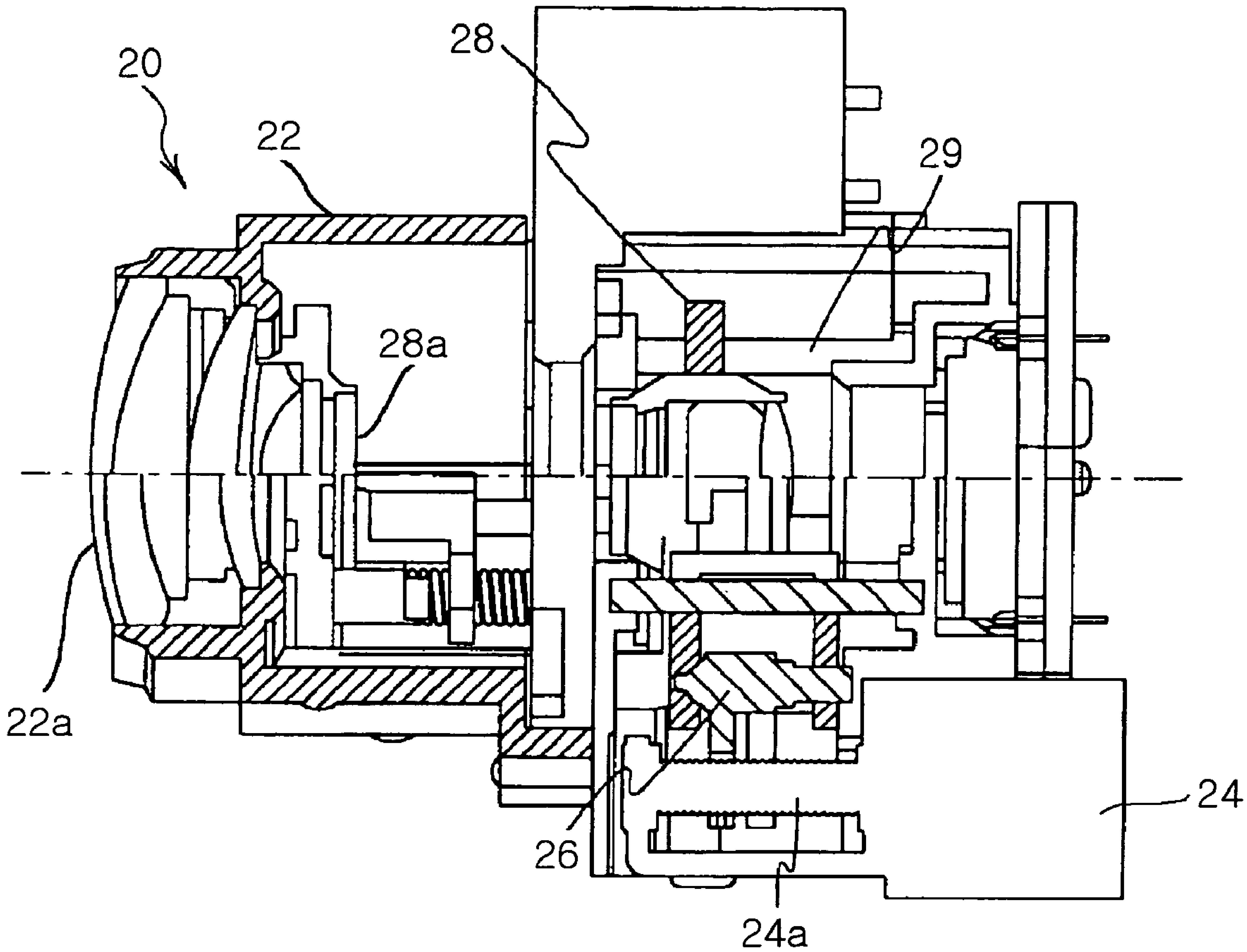
Japanese Patent Office Action, mailed Jul. 1, 2008 and issued in corresponding Japanese Patent Application No. 2006-288181.

* cited by examiner



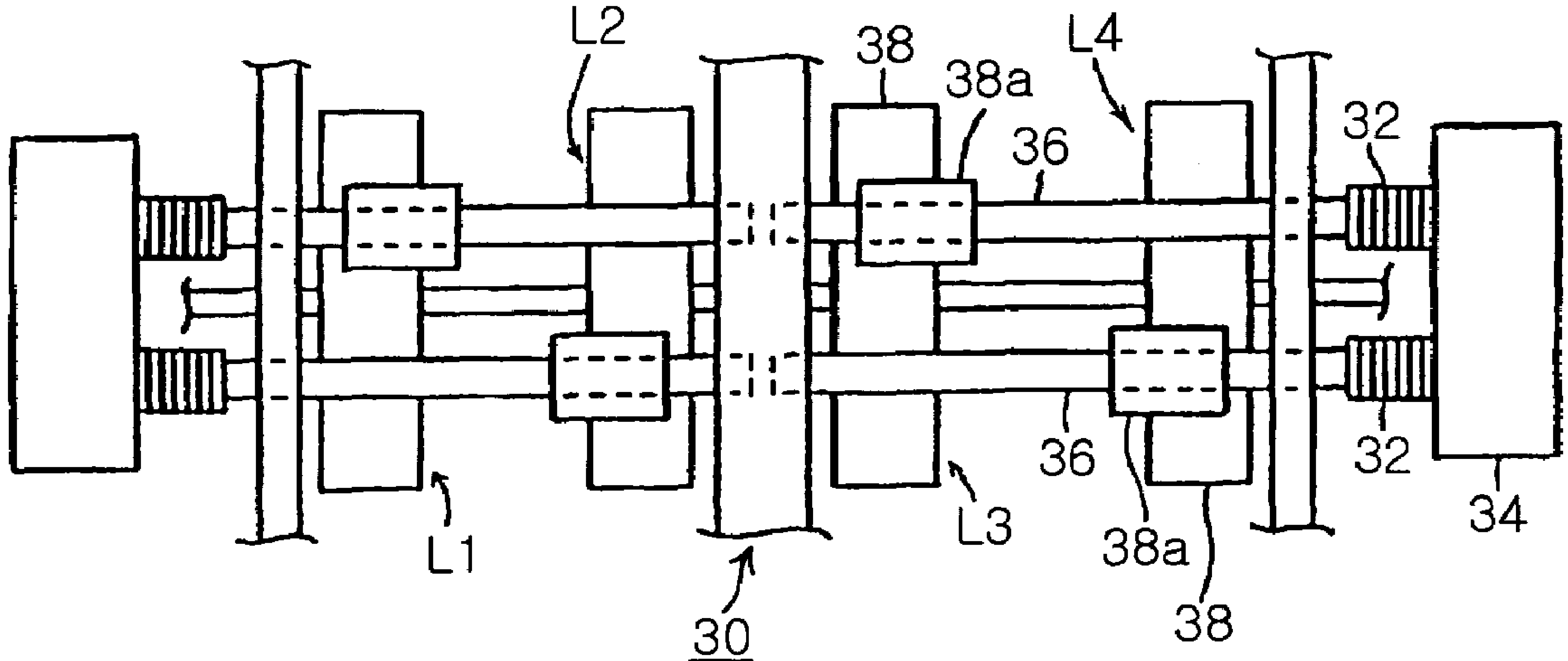
PRIOR ART

FIG. 1



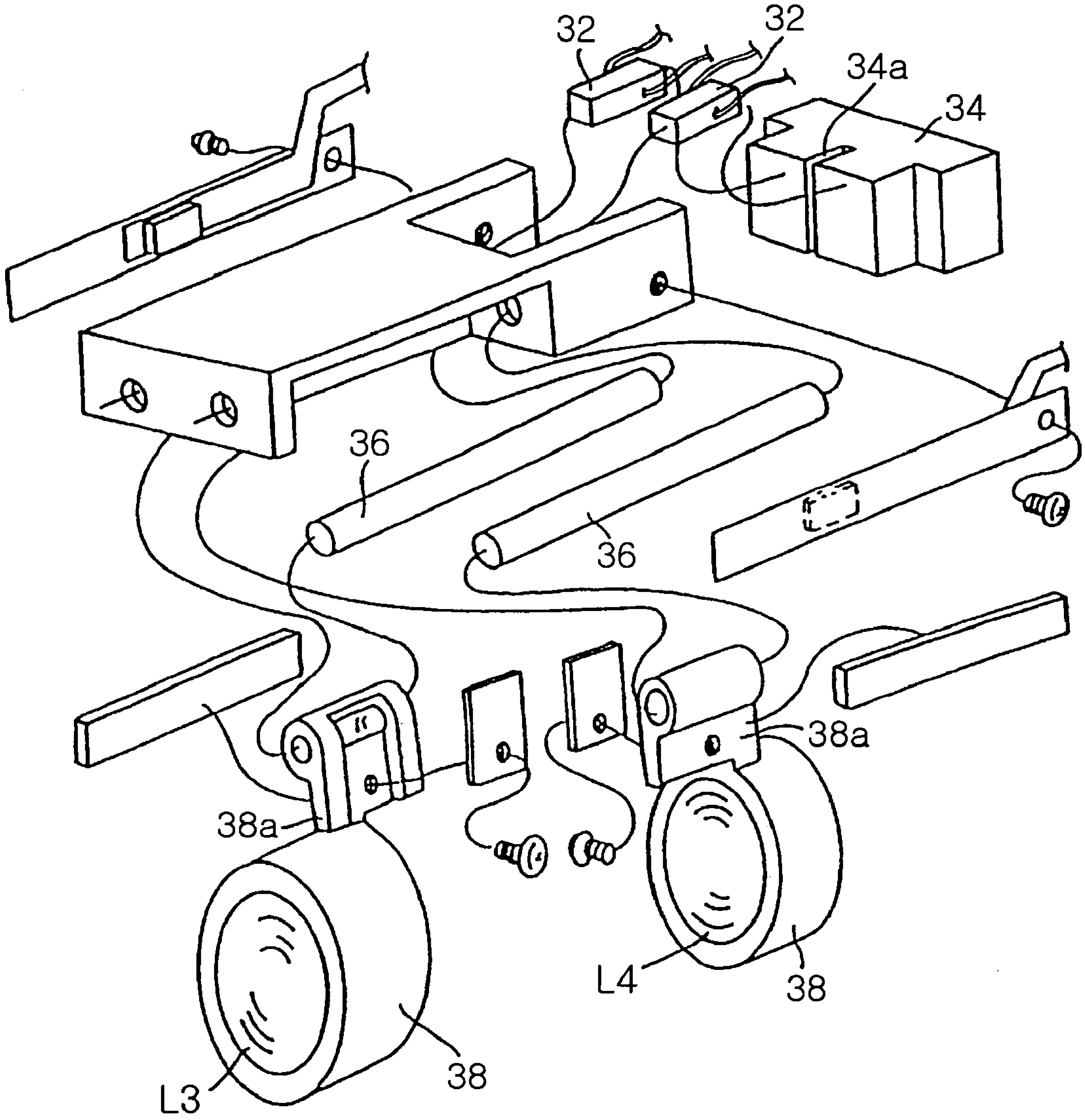
PRIOR ART

FIG. 2



PRIOR ART

FIG. 3a



PRIOR ART

FIG. 3b

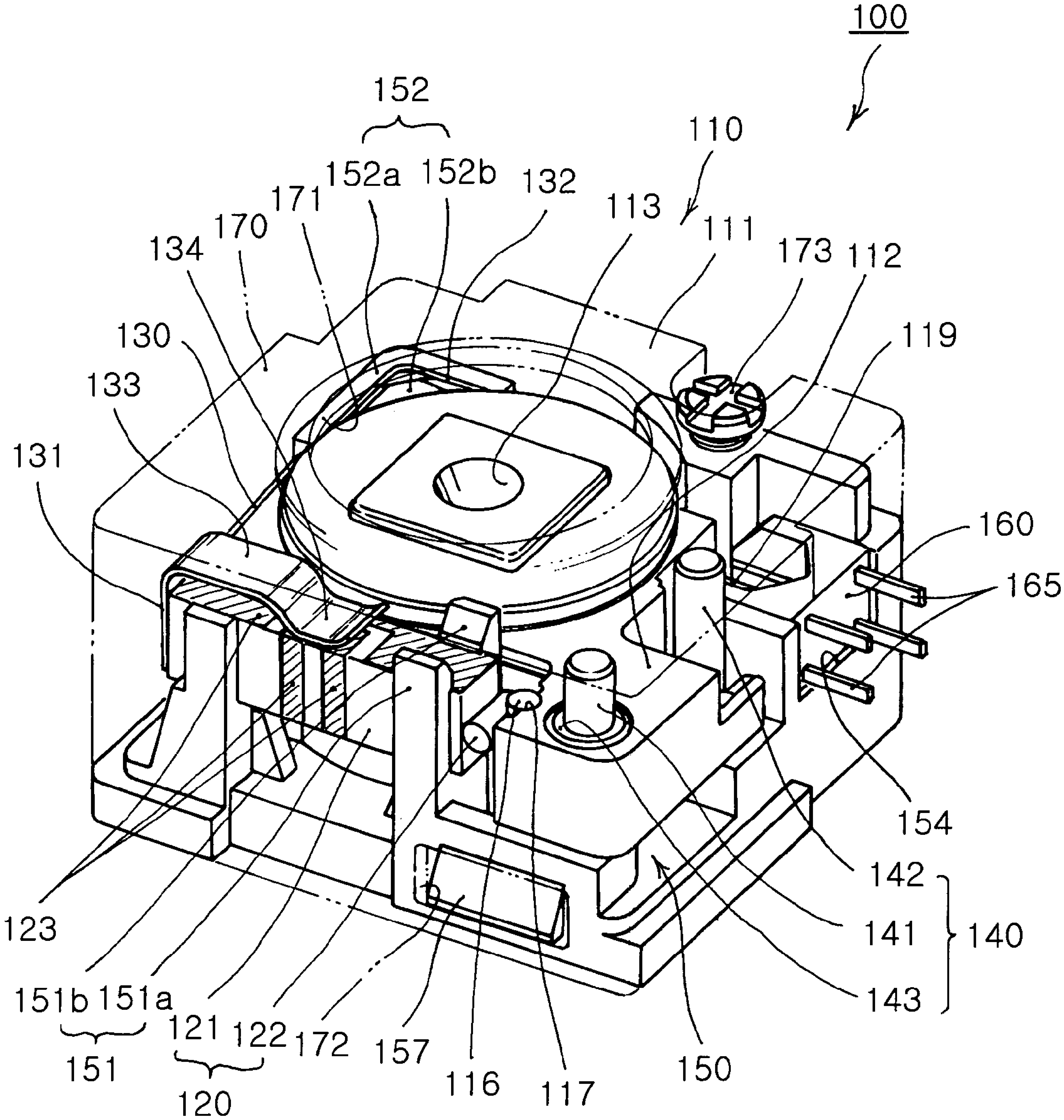

100
152
152a
152b
132
113
110
111
173
112
171
170
134
130
119
133
131
160
165
154
142
141
140
143
123
151b
151a
151
121
122
120
172
157
116
117
150

FIG. 4

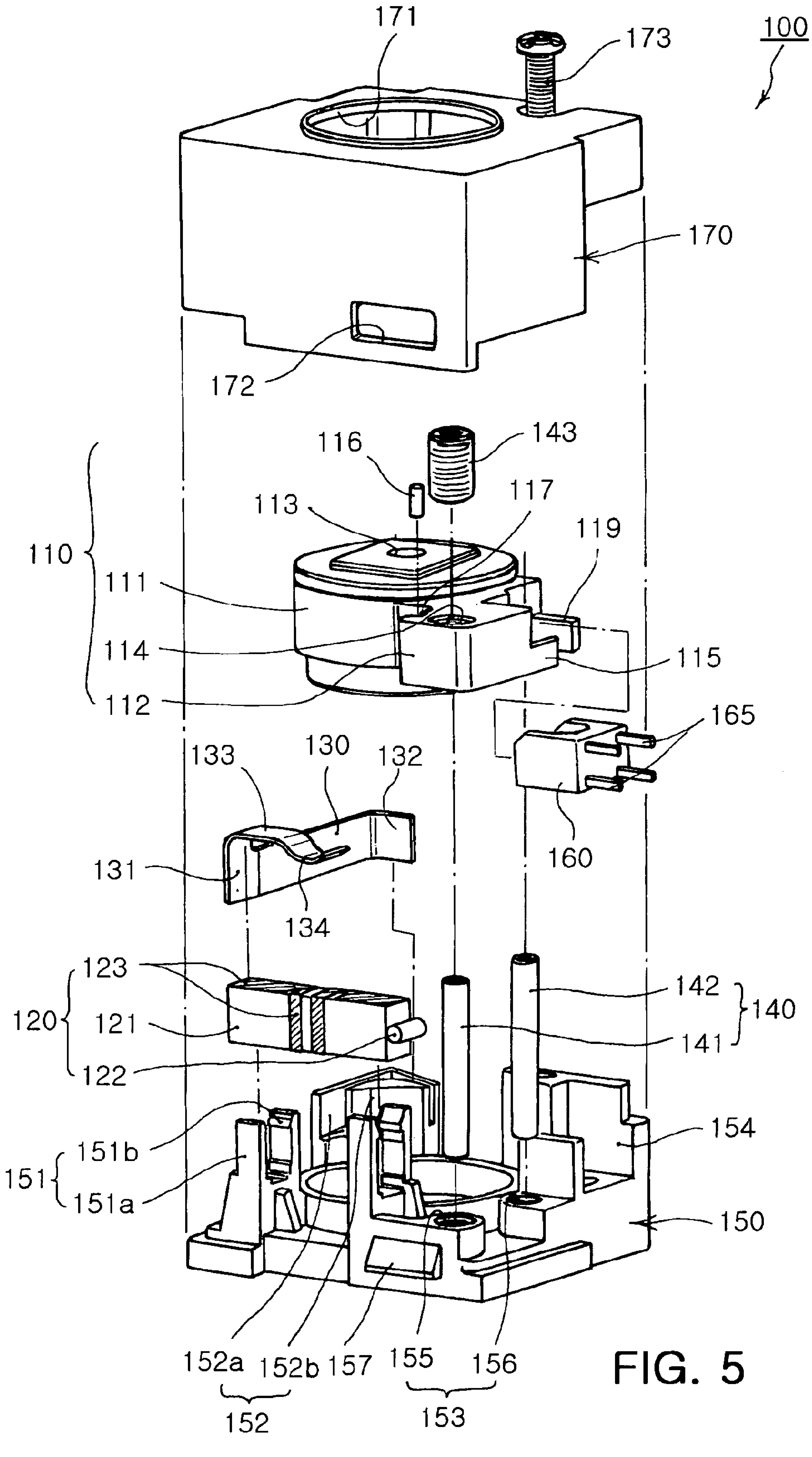

171
173
100
170
172
116
143
113
117
119
110
111
114
115
112
165
133
130
132
160
131
134
123
142
140
120
121
141
122
151b
154
151
151a
150
152a
152b
157
155
156
152
153

FIG. 5

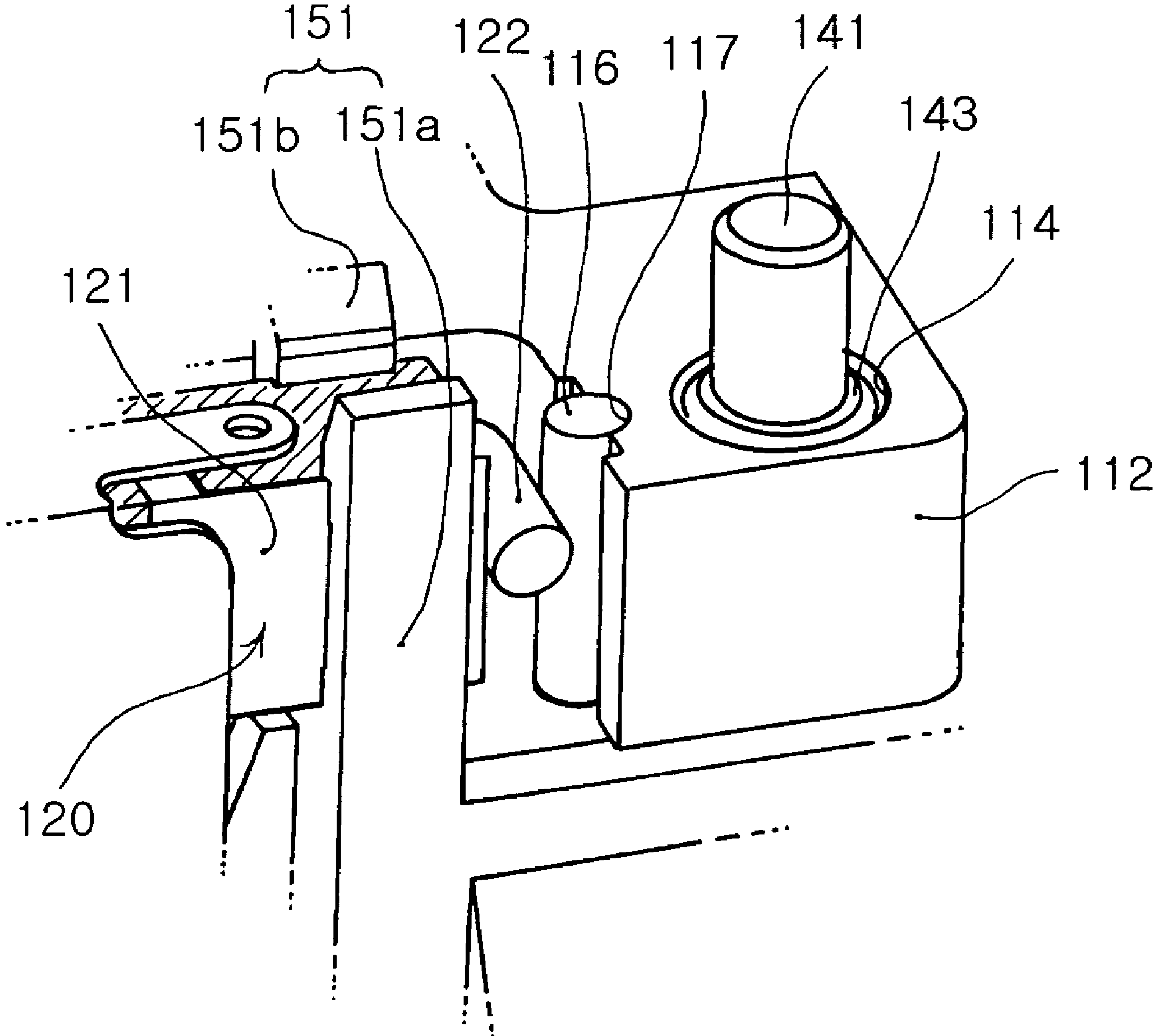
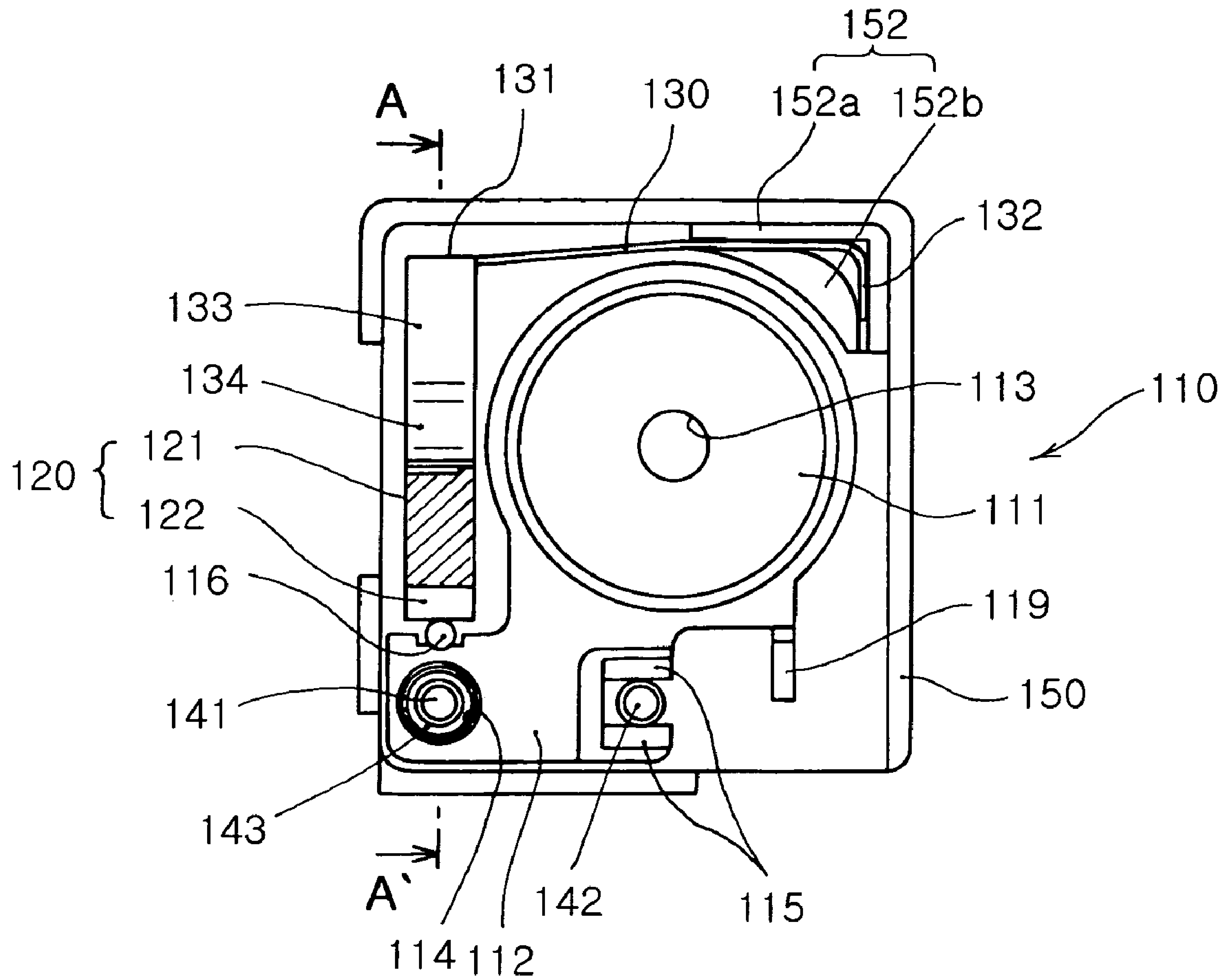
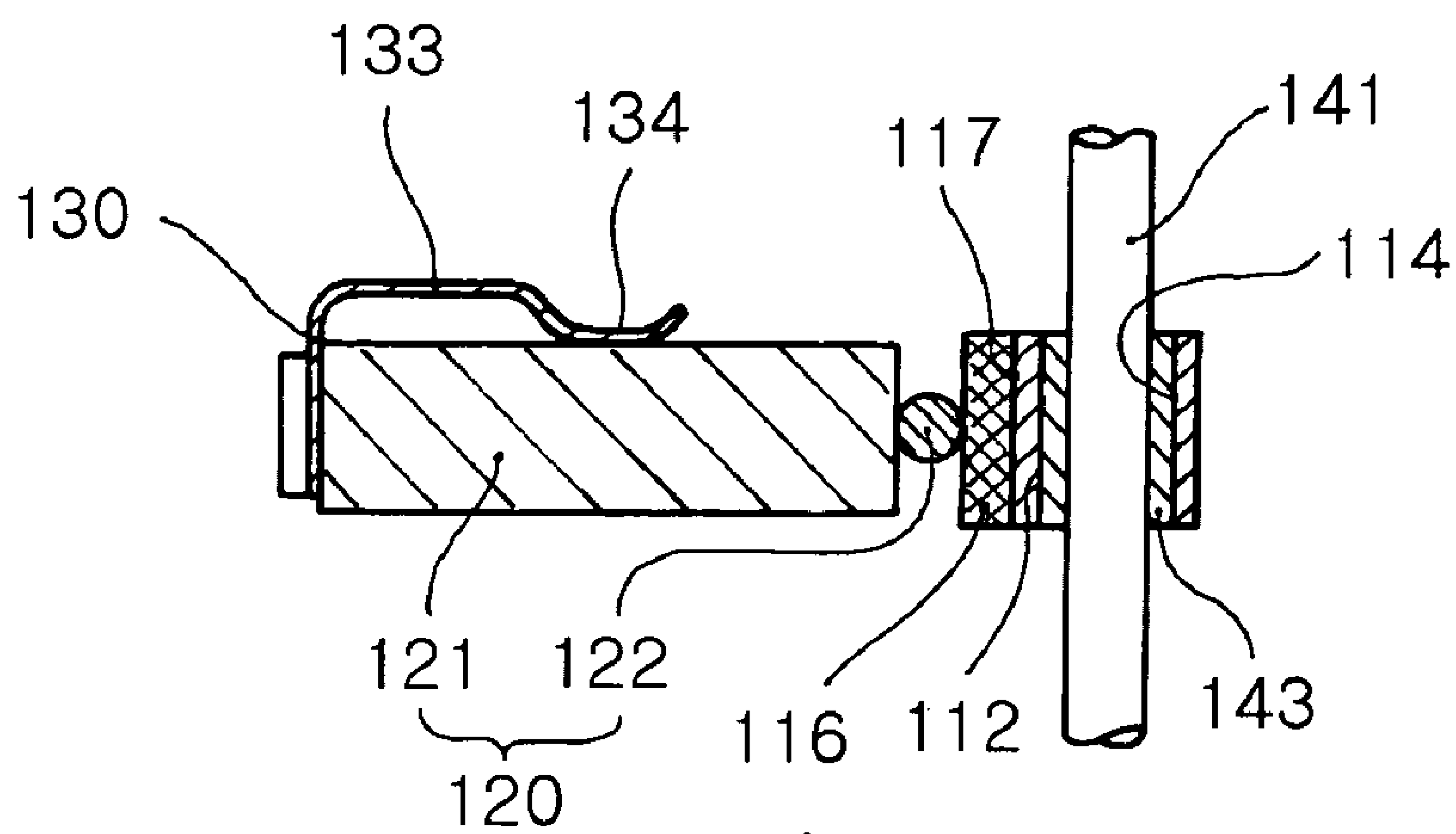


FIG. 6


152
A
131
130
152a
152b
132
133
134
113
110
120
121
122
111
116
119
141
150
143
A`
142
115
114
112


133
134
117
141
130
114
121
122
120
116
112
143

A-A`

FIG. 7

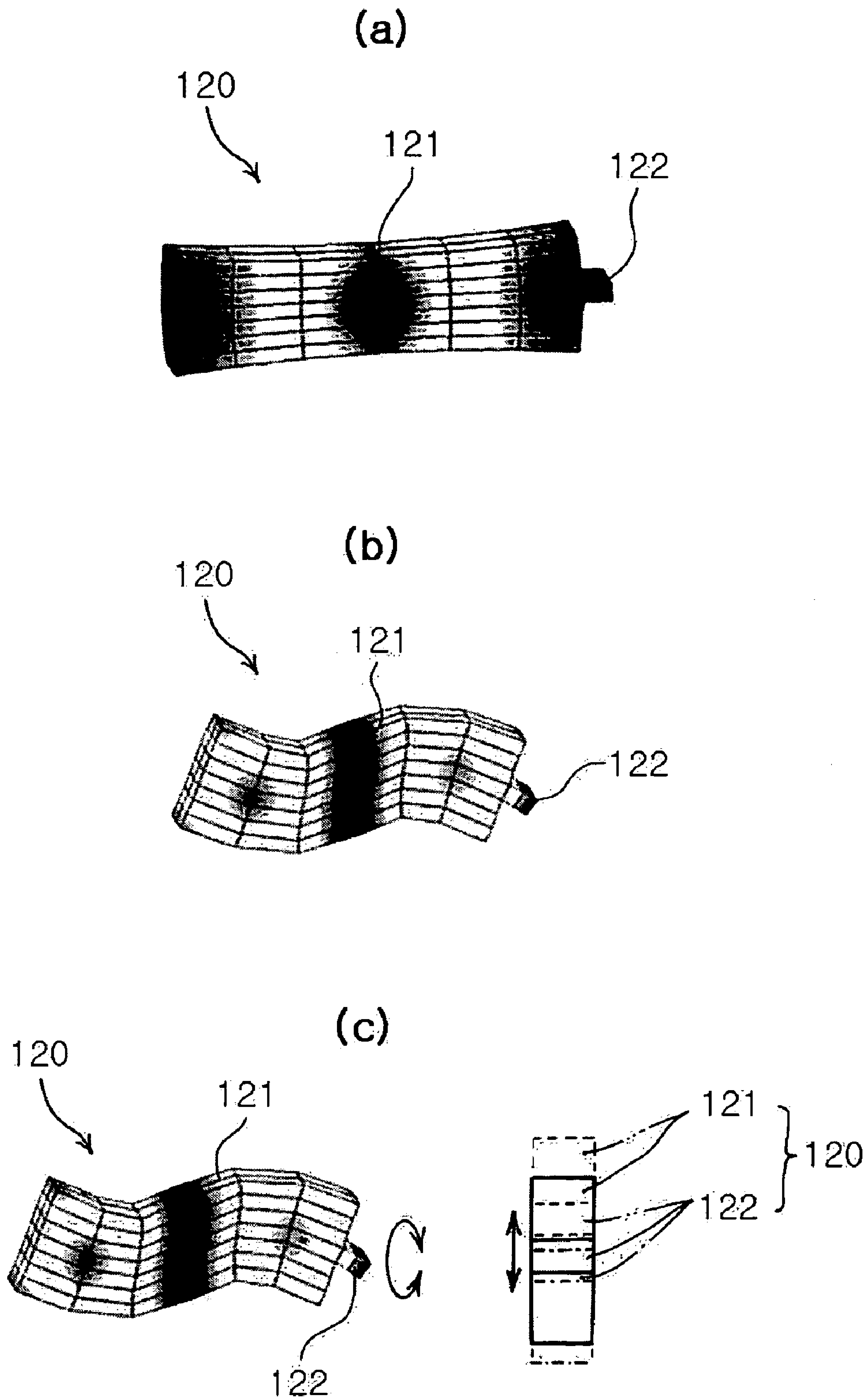


FIG. 8

LENS TRANSFER DEVICE

CLAIM OF PRIORITY

This application claims the benefit of Korean Patent Application No. 2005-100199 filed on Oct. 24, 2005, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a device for transferring a lens in use for an optical device, and more particularly, a lens transfer device with a simple structure of drive mechanism, by which a miniaturization design can be enabled, power loss related with lens transfer can be minimized and a lens can be transferred more precisely and stably.

2. Description of the Related Art

In general, an optical instrument has a lens transfer device for transferring a lens by using a cam, screw, motor or piezoelectric element. The lens transfer device uses the motor or piezoelectric element as means for generating driving force and the cam or screw for delivering the driving force.

Accordingly, the lens transfer device is adapted to enable a zooming or focusing function by transferring the lens and thus changing the relative distance of the lens.

FIG. **1** shows a zoom lens barrel for transferring a lens by using a cam, disclosed by U.S. Pat. No. 6,268,970.

According to U.S. Pat. No. 6,268,970 above, a group of lenses **12***a*, **14***a* and **16***a* are transferred along cam curves formed on barrels **12**, **14** and **16** to maintain relative distances corresponding to zoom or focal lengths.

In operation of this structure, the relative locations of the lenses **12***a*, **14***a* and **16***a* are easily determined according to the configuration of the cam curves, and an electromagnetic motor is used as a driving source. Here, a zoom lens barrel **10** is adapted to convert rotational motion of the barrel made along the cam curve into a linear motion by using a plurality of deceleration gears, and thus its structure is sophisticated.

Since the lens transfer device as above has a plurality of deceleration gears, it is difficult to miniaturize it. Furthermore, the electromagnetic motor of the lens transfer device consume a large amount of power and generates electromagnetic waves harmful to the human body as well. In addition, it is difficult to transfer the lens with high precision.

FIG. **2** shows a zoom lens mechanism of a camera designed to transfer a lens with screws.

That is, a stationary lens group **22***a* is combined to a camera body **22**, in the object side, and a receiving space is provided in the interior. In the receiving space, an electromagnetic motor **24** is installed, and a guide screw **24***a* is combined to a shaft of the motor **24**.

A power transmission member **26** is engaged on the outer periphery of the guide screw **24***a*, and a lens barrel **28** is combined to a portion of the power transmission member **26**.

In addition, a movable lens group **28***a* is combined to the lens barrel **28**, which is transferred along an optical axis by a guide shaft **29**, which is combined along the optical axis inside the camera body **22**.

Accordingly, as the motor **24** is actuated, the guide screw **24***a* rotates, transferring the power transmission member **26** along the optical axis. As the power transmission member **26** is transferred along the optical axis, the barrel **28** is guided by the guide shaft **29** also along the optical axis, enabling a zooming function.

However, the zoom lens mechanism of this camera also uses an electromagnetic motor and thus needs a plurality of deceleration gears, which in turn hinders miniaturization.

Furthermore, it is difficult to clear electromagnetic waves generating from the motor or to transfer the lens with high precision.

FIGS. **3***a* and **3***b* show a driving device **30** for transferring a lens by using piezoelectric elements in order to overcome problems related with the above described mechanisms.

That is, piezoelectric actuators **32** are fixed to a base block **34** to transfer displacement to driving rods **36**, thereby transferring lenses L**1** to L**4** by using a pressing force of slidable projections **38***a* and a force of inertia and acceleration effect of a lens frame **38**. With this structure, the driving rods **36** can transfer the lens frames **38** or slide inside the projections **38***a* according to waveforms of input voltages, thereby transferring the lens in both directions.

Electromagnetic waves are not generated since the driving device **30** does not use an electromagnetic motor. The driving device **30** can also be simplified in its structure since it does not use a final reduction gear and the like as power transmission means.

However, the driving rod **36** is fixed in length and thus the length of the barrel is not adjustable, which makes it difficult to miniaturize the device. A driving circuit is also sophisticated since a driving signal is provided as an asymmetric waveform in place of sine wave.

There are rising demands for a lens transfer device which can be installed in a small volume, be controlled precisely with high transfer resolution, and produce a sufficient displacement for transfer with a small amount of driving force

SUMMARY OF THE INVENTION

The present invention has been made to solve the foregoing problems of the prior art and therefore an object of certain embodiments of the present invention is to provide a lens transfer device which can have a micro size owing to a simplified driving structure over a conventional electromagnetic driving mechanism.

Another object of the invention is to provide a lens transfer device capable of producing a large displacement from a low input supply voltage, thereby achieving excellent transfer resolution and minimizing power loss in relation with the operation of the device.

Further another object of the invention is to provide a lens transfer device having a guide mechanism for the transfer of a lens simplified over the prior art, capable of transferring a lens more precisely and stably.

According to an aspect of the invention for realizing the object, the invention provides a lens transfer device. The lens transfer device includes at least one lens; a lens barrel having a lens receiving part with the lens arranged in an inner space thereof and an extension extending radially from an outer surface of the lens receiving part; an actuator having a body and an output member provided at a leading end of the actuator to contact the extension, the body adapted to expand/contract and bend in response to an external supply voltage to provide a driving force necessary for transfer of the lens barrel through the output member; a pressing member with a free end contacting a rear end of the actuator to force the actuator against the extension; and a guide for guiding the transfer of the lens barrel along an optical axis.

Preferably, the actuator comprises a piezoelectric ultrasonic motor having a box-shaped body comprising a plurality of piezoelectric sheets stacked one on another.

Preferably, the extension has a contact member in a vertical surface thereof facing the output member, the contact member oriented to contact and intersect perpendicularly with the output member.

More preferably, the extension has a recess formed in the vertical surface thereof to receive the contact member.

More preferably, the contact member has a height substantially the same as that of the extension.

Preferably, the pressing member comprises a leaf spring for apply an elastic force to the actuator, the leaf spring having a free end bent outward to contact the rear end of the actuator and a fixing end bent toward the lens barrel.

More preferably, the pressing member further including an upper fixing portion extending at a predetermined length toward the body from the free end of the pressing member to force an upper surface of the body of the actuator directly downward.

More preferably, the upper fixing portion has a bent portion convexed downward from a leading end of the fixing portion to contact and apply elastic force to the upper surface of the body.

Preferably, the pressing member is formed longer than the actuator.

Preferably, the extension has a guide hole perforated therein to be parallel with the optical axis, wherein the guide has a first guide rod of a predetermined length inserted into the guide hole of the extension and a second guide rod of a predetermined length with an outer periphery contacting the extension to prevent the lens barrel from rotating.

More preferably, the first guide rod is assembled to the guide hole via one of a bushing and an oilless bearing.

More preferably, the first guide rod has a center located coplanar with a contact point where the output member of the actuator meets the contact member of the extension.

More preferably, the extension has a pair of guide support protrusions projecting therefrom in a direction perpendicular to a pressing direction of the pressing member, and wherein the outer periphery of the second guide rod is adapted to contact the guide support protrusions of the extension.

More preferably, the first and second guide rods are coated on outer peripheries with one material of fluorocarbons and molybdenum sulfides to minimize frictional force.

The lens transfer device further includes a base on which the lens barrel is seated, wherein the base has a first holder fixing the body of the actuator so that the output member of the actuator contacts the extension of the lens barrel, a second holder fixing a stationary end of the pressing member and a third holder fixing a lower end of the guide.

More preferably, the first holder has at least one U-shaped elastic fixing piece supporting a lower surface and elastically contacting both side surfaces of the body and a holding projection extending from a top end of the elastic piece to elastically contact an upper surface of the body.

More preferably, the second holder has a pair of vertical ribs which are L-shaped with a gap therebetween so that the stationary end of the pressing member is fixedly inserted into the gap.

More preferably, the third holder has first and second fixing holes receiving lower ends of the first and second guide rods of the guide, respectively.

Preferably, the lens barrel has a detection bar formed at one side thereof, and the device further includes a location sensor for detecting vertical location of the detection bar.

Preferably, the device further includes a housing for protecting the lens barrel, the actuator, the pressing member and the guide from external environments.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and other advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

FIG. **1** is a cross-sectional view illustrating a conventional lens transfer device using a cam;

FIG. **2** is a cross-sectional view illustrating a conventional lens transfer device using a screw;

FIG. **3***a* is a plan view illustrating a conventional lens transfer device using a piezoelectric element;

FIG. **3***b* is a partial, exploded perspective view of FIG. **3***a*;

FIG. **4** is a perspective view illustrating a lens transfer device according to the invention;

FIG. **5** is an exploded perspective view illustrating a lens transfer device according to the invention;

FIG. **6** is a detailed view illustrating an actuator in contact with an extension in the lens transfer device according to the invention;

FIG. **7** is a plan view illustrating a lens transfer device according to the invention; and

FIG. **8** illustrates an actuator adopted in the lens transfer device according to the invention, in which (a) illustrates a body expanded/contracted in a longitudinal direction, (b) illustrates the body bent in a vertical direction, and (c) illustrates the body having a synthetic transformation of expansion/contraction and bending.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which preferred embodiments of the invention are shown.

FIG. **4** is a perspective view illustrating a lens transfer device **100** according to the invention, and FIG. **5** is an exploded perspective view illustrating the lens transfer device **100** as shown in FIG. **4**.

Referring to FIGS. **4** and **5**, the lens transfer device **100** of the invention includes a lens barrel **110** with at least one lens contained therein, an actuator **120** for supplying a driving force to transfer the lens, a pressing member **130** for pressing the actuator **120** and a guide **140** for guiding the transfer of the lens barrel **110**.

The lens barrel **110** includes a lens receiving part **111** and an extension **112**. The lens receiving part **111** is of a container having a predetermined size of inner space which receives at least one lens to be oriented along the optical axis. The extension **112** is of a substantially box-shaped structure, extended in a radial direction from an outer surface of the lens receiving part **111**.

While the extension **112** may be formed integrally with the lens barrel **110** at injection molding thereof, it is not intended to be limiting. Rather, the extension **112** may be injection-molded separately and then assembled to the cylindrical lens receiving part **111**, which is also injection-molded separately.

A predetermined size of incident hole **113** is formed on the upper surface of the lens receiving part **111** so that its center is aligned with the optical axis. The extension **112** has a guide hole **114** perforated therein to be parallel with the optical axis so that a first guide rod **141** of the guide **140** is assembled into the guide hole **114**. The extension **112** also has guide support protrusions **115** supporting a second guide rod **142** of the guide **140**.

In addition, as shown in FIGS. **4** and **5**, the actuator **120** is of a box-shaped piezoelectric ultrasonic motor composed of a body **121** and an output member **122**. The body **121** is of a piezoelectric element with a plurality of electrode terminals **123** for receiving external supply voltage are provided on the outer surface thereof. The piezoelectric element of the body **121** is composed of a plurality of piezoelectric sheets stacked one on another so as to contract/expand longitudinally and bend vertically in response to a supply voltage applied through the electrode terminals **123**.

The output member **122** is of a cylindrical friction member integrally mounted on a leading end facing the extension **112**.

The output member **122** is preferably made of a material such as ceramic and metal which has an excellent abrasion resistance and a relatively large friction coefficient.

The actuator **120** is fixedly arranged in a first holder **151** extending from a base **150** on which the lens barrel **110** is mounted.

FIG. **6** is a detailed view illustrating an actuator in contact with the extension in the lens transfer device according to the invention. Referring to FIG. **6**, a contact member **116** is provided integrally in a vertical surface of the extension **112** facing the output member **122** of the actuator **120** to be in contact with the output member **122**.

The contact member **116** is a friction member mounted on the vertical surface of the extension **112**, and arranged to intersect perpendicularly with the output member **122** to make a point contact therebetween. Likewise to the output member **122**, the contact member **116** is preferably made of a material such as ceramic and metal which has an excellent abrasion resistance and a relatively large friction coefficient.

While the contact member **116** of this embodiment has been illustrated as a structure arranged vertically to contact the output member **122** which is arranged horizontally of the actuator **120**, it is not intended to be limiting. Rather, the contact member **116** may be arranged horizontally to contact the output member **122** which is arranged vertically of the actuator **120**.

In addition, while the output member **122** and the contact member **116** of this embodiment have been illustrated as being cylindrical, it is not intended to be limiting. Rather, the output member **122** and the contact member **116** may have a semi-circular or elliptical cross section to make a point contact therebetween.

Furthermore, a groove **117** is preferably provided in the vertical surface of the extension **122** facing the output member **122** so that the contact member **116** can be fixedly placed in the groove **117**.

In this case, the contact member **116** preferably has a length substantially the same as the height of the extension **112** so that it can contact the output member **122** more securely and stably.

The output member **122** is guided to a specific position under a specific amount of pressing force by means of an additional jig (not shown) so that the upper surface thereof is parallel with the actuator **120** and mounted to the actuator **120** in the pressed position by using a thermosetting resin adhesive.

In addition, the contact member **116** is guided to a specific position under a specific amount of pressing force by means of an additional jig (not shown) so as to be parallel axially with the first guide rod **141** and then mounted to the extension **116** by using a thermosetting resin adhesive.

The pressing member **130** is of an elastic body with a free end **131** and a stationary end **132**. The stationary end **132** is fixed to the base **150** so that the free end **131** can contact the rear end of the actuator **120** opposite to the leading end thereof where the output member **122** is placed to force the actuator **120** toward the extension **112**.

The pressing member **130** is preferably provided as a leaf spring in which the free end **131** is bent to contact the rear end of the actuator **120** and the stationary end **132** fixed to the base **150** is bent toward the lens barrel **110** to generate an elastic force.

Here, the pressing member **130** is preferably designed to be longer than the actuator in order to potentially produce an adjustable and suitable amount of pressing force.

The pressing member **130** has an upper fixing portion **133** extending to a predetermined length from the body at the free end **131** thereof to apply a downward force to an upper surface of the body **121** of the actuator **120**.

The pressing member **130** also has a bend **134** at the leading end of the fixing portion **133**, which is bent or convexed downward to be in contact with and apply an elastic force to the upper surface of the body **121**.

As shown in FIGS. **4**, **5** and **7**, the first and second guide rods **141** and **142** are provided in the guide **140** to guide the lens barrel **110** when the lens barrel **110** is reciprocally transferred along the optical axis by the driving force applied from the actuator **120**.

The first and second guide rods **141** and **142** are cylindrical members of a predetermined length. The first guide rod **141** is fixedly inserted by the lower end into a first fixing hole **155** of the base **150** to be parallel with the optical axis, and the second guide rod **142** is fixedly inserted into a second fixing hole **156** of the base **150** to be parallel with the optical axis.

The first guide rod **141** is a rod member of a specific length and slidably assembled by means of a bushing **143**. The bushing **143** is inserted into the guide hole **114** extending through the extension **112** to be parallel with the optical axis. As an alternative, the bushing **143** may be replaced by an oilless bearing.

The center of the first guide rod **141** is located coplanar with a contact point where the output member **122** of the actuator **120** meets the contact member **116** of the extension **112**.

The second guide rod **142** is a rod member of a predetermined length with its outer periphery in point contact with a pair of the guide support protrusions **115** of the extension **112**.

The pair of guide support protrusions **115** are provided in opposing portions of the extension **112** to prevent any rotational component from occurring during the vertical transfer of the lens barrel **110**. Each guide support protrusion **115** is extended for a predetermined length in a direction perpendicularly crossing the pressing direction of the pressing member **130**.

Preferably, the first and second guide rods **141** and **142** may be coated on the outer periphery with one material of fluorocarbons and molybdenum sulfides, such that when the lens barrel **110** is vertically transferred by a driving force applied from the actuator **120**, the first and second guide rods **141** and **142** can generate a frictional force smaller than that occurring between the output member **122** and the contact member **116**.

The lens transfer device **100** of this embodiment also includes the base **150** on which the lens barrel **110** is seated and an image sensor (not shown) and a board (not shown) are arranged as shown in FIGS. **4** and **5**.

The base **150** is a injection-molded resin structure with first to third holders **151** to **153** thereof to fixedly locate the actuator **120**, the pressing member **130** and the guide **140**.

The first holder **151** is a stationary structure fixedly locating the body **121** so that the output member **122** of the actuator **120** contacts the extension **112** of the lens barrel **110**.

The first holder **151** has U-shaped elastic pieces **151***a* (or at least one elastic piece) for supporting the underside surface and elastically contacting both side surfaces of the body **121** and holding projections **151***b* each extending respectively from the top end of each of the elastic pieces **151***a* to elastically contact the upper surface of the body **121**.

Accordingly, the body **121** of the actuator **120** is inserted from above into between the elastic pieces **151***a*. Once the body **121** is inserted between the elastic pieces **151***a*, the holding pieces **151***b* hold the body **121** so that the body **121** does not separate to the outside or shake vertically or laterally.

In addition, the second holder **152** is a stationary structure provided at one corner of the base **150** to fix the stationary end **132** of the pressing member **130**.

The second holder **152** has a pair of vertical ribs **152***a* and **152***b*, which are L-shaped with a gap therebetween so that the stationary end **132** of the pressing member **130** is fixedly inserted into the gap.

In the third holder **153**, the first fixing hole **155** receives the lower end of the first guide rod **141** of the guide **140**, the second fixing hole **156** receives the lower end of the second guide rod **142** of the guide **140**, in which the centers of the first and second fixing holes **155** and **156** are placed coplanar.

The lens barrel **110** has a detection bar **119** formed integrally at one side thereof, and the lens transfer device **100** also has a location sensor **160** for detecting the vertical location of the detection bar **119** to determine the position change of the lens barrel **110**.

The location sensor **160** is fixed in position to a fourth holder **54** of the base **150**, which is formed in an area corresponding to the detection bar **119**. The location sensor **160** has a plurality of terminals **165** for transmitting/receiving signals.

The lens transfer device **100** also includes a housing **170** arranged over the base **150** as shown in FIGS. **4** and **5** to protect the lens barrel **110**, the actuator **120**, the pressing member **130** and the location sensor **160** from external environments.

The housing **170** is of a resin structure, and has an opening **171** and an assembly hole **172**. The opening **171** is formed at a predetermined size in the upper surface of the housing **170** to expose the incident hole **113** of the lens barrel **110**. The assembly hole **172** is perforated in the housing **170** to be engaged with an assembly protrusion **157** projected from an outer surface of the base **150**.

The housing **170** is combined with the base **150** by means of a fixing screw **173** engaging into a screw hole (now shown) of the base **150**.

According to the lens transfer device **100** of this embodiment, the process of transferring the lens barrel **110** with at least one lens mounted therein along an optical axis is carried out by applying external supply voltage to the actuator **120** through the electrode terminals **123** formed on the body **121** of the actuator **120** so that the body **121** with the piezoelectric sheets transform their shape to generate a driving force to transfer the lens barrel **110**.

At a supply voltage in the range of resonant frequency of about 222 kHz applied to the body **121** of the actuator **120**, the body **121** transforms its shape longitudinally with the output member **122** as shown in FIG. **8**(*a*). At a supply voltage in the range of resonant frequency of about 230 kHz applied to the body **121**, the body **121** transforms itself into a serpent (S) shape as shown in FIG. **8**(*b*).

Accordingly, at a supply voltage in the range of resonant voltage of about 230 kHz intermediating between the above resonant frequencies applied to the body **121**, the body **121** has an expansion/contraction vibration mode in a longitudinal direction and a bending vibration mode in a height direction occurring simultaneously. Then, the output member **122** mounted at the leading end of the body **121** vibrates along an elliptical locus when seen laterally of the body **121** and vibrates linearly when seen in front of the body **121**. Such a motion is generated through synthesis of the expansion/contraction and the bending.

Since the actuator **120** is fixed to the first holder of the base so that the elliptical motion is restrained, the output member **122** performs a linear motion, of which direction is converted according to the polarity of the supply voltage applied to the body **121**.

The output member **122** outputting only a vertical vibration locus is adapted to transfer the driving force via the contact member **116** of the extension **112** of the lens barrel **110** to be transferred so that the lens barrel **110** is elevated or lowered in the direction of the optical axis along the first and second guide rods **141** and **142**.

Since the frictional force generated between the output member **122** and the contact member **116** is larger than a frictional force from the first guide rod **141** and the output member **122** and the contact member **116** perform a point contact with the optical axis of the lens barrel **110** not offset with respect to the vertical axis, the vertical transfer of the lens barrel **110** can be carried out more stably.

Here, the contact point where the output member **122** meets the contact member **116** is maintained constant under the elastic force of the pressing member **130** that forces the actuator **120** against the extension **112**.

Since the contact point where the output member **122** and the contact member **116** meet each other is located coaxially with the center of the guide hole **114**, the first guide road and the bushing **143**, the elastic force of the pressing member **130** directed toward the extension can be transferred to the extension **112** without loss, thereby maximizing the performance of the actuator **120**.

The transfer of the lens barrel **110** by the driving force from the actuator **120** is carried out along the first guide rod **141** which is assembled into the guide hole **114** of the extension **112**.

Here, in order to prevent any gap occurring between the inner periphery of the guide hole **114** and the outer periphery of the first guide rod **141** owing to the difference between the roundness of the inside diameter of the guide hole **114** and the roundness of the outside diameter of the guide rod **141**, the first guide rod **141** is assembled to the guide hole **114** via the bushing **143**. With this, the first guide rod **141** is not offset with respect to but remains parallel with the optical axis so that the vertical transfer of the lens barrel **110** can be performed more stably.

In addition, the second guide rod **142** arranged vertical and separated with a predetermined distance from the first guide rod **141** performs a point contact with the pair of guide support protrusions **115** of the extension **112** so that the outer periphery of the second guide rod **142** is protruded perpendicularly with respect to the pressing direction of the pressing member **130**. This as a result prevents the lens barrel **110** from rotating about the first guide rod **141** during the vertical transfer of the lens barrel **110**.

Since the first and second guide rods **141** and **142** are coated on the outer periphery with a coating material such as fluorocarbons and molybdenum sulfides, a low friction coefficient is obtained from between the first guide rod **141** and the bushing **143** and between the second guide rod **142** and the guide protrusions **115**. This friction coefficient is lower than that obtained between the output member **122** and the contact member **116** which are made of ceramics or metal of excellent friction resistance and relatively high friction coefficient. Accordingly, the power loss of the actuator **120** can be minimized and the vertical transfer of the lens barrel **110** can carried out more stably.

In addition, the location sensor **160** detects the motion of the lens barrel **110** which is vertically transferred along the first and second guide rods **141** and **142**. The location sensor **160** locates the lens barrel **110** by detecting the detection bar **119** protruding from the lens barrel **110**.

While the present invention has been described with reference to the particular illustrative embodiments and the accompanying drawings, it is not to be limited thereto but will be defined by the appended claims. It is to be appreciated that those skilled in the art can substitute, change or modify the embodiments into various forms without departing from the scope and spirit of the present invention.

As set forth above, the invention provides a driving mechanism for transmitting a driving force of an actuator toward a lens barrel, in which the actuator is in point-contact with the extension extending radially from the lens barrel and forced against the extension by the pressing member. The driving mechanism can be further simplified over a conventional cam/electromagnetic driving mechanism, thereby further miniaturizing an optical instrument.

In addition, the invention can minimize any loss of driving force transmitted to the lens barrel subject to transfer as well as any loss owing to frictional force during the transfer of the lens barrel, thereby producing a large amount of displacement from a low input voltage and enhancing driving efficiency.

Furthermore, a simple structure of guide mechanism is provided to guide the transfer of the lens barrel in more precisely and stably, and thus images of more excellent qualities can be produced.

What is claimed is:

1. A lens transfer device comprising:

at least one lens;

a lens barrel having a lens receiving part with the lens arranged in an inner space thereof and an extension extending radially from an outer surface of the lens receiving part;

an actuator having a body and an output member provided at a leading end of the actuator to contact the extension, the body adapted to expand/contract and bend in response to an external supply voltage to provide a driving force necessary for transfer of the lens barrel through the output member;

a pressing member with a free end contacting a rear end of the actuator to force the actuator against the extension; and

a guide for guiding the transfer of the lens barrel along an optical axis,

wherein the pressing member comprises a leaf spring to apply an elastic force to the actuator, the leaf spring having a free end bent outward to contact the rear end of the actuator and a fixing end bent toward the lens barrel, and

wherein the pressing member further includes an upper fixing portion extending at a predetermined length toward the body from the free end of the pressing member to force an upper surface of the body of the actuator directly downward.

2. The lens transfer device according to claim **1**, wherein the actuator comprises a piezoelectric ultrasonic motor having a box-shaped body comprising a plurality of piezoelectric sheets stacked one on another.

3. The lens transfer device according to claim **1**, wherein the extension has a contact member in a vertical surface thereof facing the output member, the contact member oriented to contact and intersect perpendicularly with the output member.

4. The lens transfer device according to claim **3**, wherein the extension has a recess formed in the vertical surface thereof to receive the contact member.

5. The lens transfer device according to claim **3**, wherein the contact member has a height substantially the same as that of the extension.

6. The lens transfer device according to claim **1**, wherein the upper fixing portion has a bent portion convexed downward from a leading end of the fixing portion to contact and apply elastic force to the upper surface of the body.

7. The lens transfer device according to claim **1**, wherein the pressing member is formed longer than the actuator.

8. The lens transfer device according to claim **1**, wherein the extension has a guide hole perforated therein to be parallel with the optical axis, and

wherein the guide has a first guide rod of a predetermined length inserted into the guide hole of the extension and a second guide rod of a predetermined length with an outer periphery contacting the extension to prevent the lens barrel from rotating.

9. The lens transfer device according to claim **8**, wherein the first guide rod is assembled to the guide hole via one of a bushing and an oilless bearing.

10. The lens transfer device according to claim **8**, wherein the first guide rod has a center located coplanar with a contact point where the output member of the actuator meets the contact member of the extension.

11. The lens transfer device according to claim **8**, wherein the extension has a pair of guide support protrusions projecting therefrom in a direction perpendicular to a pressing direction of the pressing member, and wherein the outer periphery of the second guide rod is adapted to contact the guide support protrusions of the extension.

12. The lens transfer device according to claim **8**, wherein the first and second guide rods are coated on outer peripheries with one material of fluorocarbons and molybdenum sulfides to minimize frictional force.

13. The lens transfer device according to claim **1**, further comprising a base on which the lens barrel is seated,

wherein the base has a first holder fixing the body of the actuator so that the output member of the actuator contacts the extension of the lens barrel, a second holder fixing a stationary end of the pressing member and a third holder fixing a lower end of the guide.

14. The lens transfer device according to claim **13**, wherein the first holder has at least one U-shaped elastic fixing piece supporting a lower surface and elastically contacting both side surfaces of the body and a holding projection extending from a top end of the elastic piece to elastically contact an upper surface of the body.

15. The lens transfer device according to claim **13**, wherein the second holder has a pair of vertical ribs which are L-shaped with a gap therebetween so that the stationary end of the pressing member is fixedly inserted into the gap.

16. The lens transfer device according to claim **13**, wherein the third holder has first and second fixing holes receiving lower ends of the first and second guide rods of the guide, respectively.

17. The lens transfer device according to claim **1**, the lens barrel has a detection bar formed at one side thereof,

the device further comprising a location sensor for detecting vertical location of the detection bar.

18. The lens transfer device according to claim **1**, further comprising a housing for protecting the lens barrel, the actuator, the pressing member and the guide from external environments.

* * * * *